

IN THE CLAIMS

This listing of claims will replace all prior versions, and listings, of claims in the application.

1. (Original) A semiconductor device comprising:

a first semiconductor layer of a first conductivity type;

a second semiconductor layer of a second conductivity type formed on a main surface of the first semiconductor layer;

a third semiconductor layer of the first conductivity type formed in the second semiconductor layer and electrically isolated from the first semiconductor layer;

a trench formed to extend from the surface of the third semiconductor layer and penetrate the third semiconductor layer and having depth to reach at least a portion lying near the first semiconductor layer;

a first insulating film formed on side walls and a bottom portion of the trench;

a first electrode formed at least partly on the first insulating film in the trench and electrically isolated from the first to third semiconductor layers; and

a fourth semiconductor layer of the first conductivity type formed near the trench on an interface between the first and second semiconductor layers and having an impurity concentration higher than that of the first semiconductor layer;

wherein an impurity concentration profile of the second semiconductor layer has a first peak which determines at least threshold voltage and a second peak which determines a dose amount of the impurities.

2. (Original) The semiconductor device according to claim 1, wherein the first peak exists near an interface between the third semiconductor layer and the second semiconductor layer.

3. (Original) The semiconductor device according to claim 1, wherein the first peak exists near an interface between the fourth semiconductor layer and the second semiconductor layer.

4. (Original) The semiconductor device according to claim 1, wherein the impurity concentration profile of the second semiconductor layer has a plurality of peaks.

5. (Original) The semiconductor device according to claim 1, wherein film thickness of a portion of the first insulating film which lies near the bottom portion of the trench is larger than that of a portion of the insulating film which lies on the side wall portion of the trench.

6. (Original) The semiconductor device according to claim 1, wherein the fourth semiconductor layer is formed near the bottom portion of the trench.

7. (Original) The semiconductor device according to claim 1, wherein the trench is formed to penetrate at least part of the first semiconductor layer and the fourth semiconductor layer is formed on the side wall portion of the trench.

8. (Withdrawn) The semiconductor device according to claim 1, wherein the fourth semiconductor layer is a current passage acquiring layer formed between the first and second

semiconductor layers and the trench is formed to have depth to reach the current passage acquiring layer.

9. (Withdrawn) The semiconductor device according to claim 8, wherein the current passage acquiring layer contains carbon.

10. (Original) The semiconductor device according to claim 1, wherein an interface between the second and first semiconductor layers is shallow in a portion near the trench and deep in a peripheral portion thereof.

11. (Original) The semiconductor device according to claim 10, wherein Y1 and Y2 are set to satisfy the relation of  $0 < Y1 < 1.2 [\mu\text{m}]$  and  $Y2 < 3 [\mu\text{m}]$  when the depth from the surface of the third semiconductor layer to the deepest bottom portion of the second semiconductor layer is set to Y2 [ $\mu\text{m}$ ] and the depth from the deepest bottom portion of the trench to the deepest bottom portion of the second semiconductor layer is set to Y1 [ $\mu\text{m}$ ].

12. (Original) The semiconductor device according to claim 1, further comprising a fifth semiconductor layer of the second conductivity type formed adjacent to the third semiconductor layer on the second semiconductor layer.

13. (Original) The semiconductor device according to claim 1, wherein the first electrode is formed of polysilicon.

14. (Original) The semiconductor device according to claim 1, wherein an upper portion of the first electrode partly protrudes from the trench.

15. (Original) The semiconductor device according to claim 14, further comprising a low-resistance layer formed on at least part of the surface of the first electrode which protrudes from the trench.

16. (Currently Amended) The semiconductor device according to claim ~~[[1]]~~ 12, further comprising a second electrode formed on a rear surface of the first semiconductor layer which is opposite to the main surface thereof; a second insulating film formed on the first insulating film and the first electrode; and a third electrode formed on the third semiconductor layer, fifth semiconductor layer and second insulating film.

17. (Currently Amended) A semiconductor device comprising:

- a first semiconductor layer of a first conductivity type;
- a second semiconductor layer of a second conductivity type formed on a main surface of the first semiconductor layer;
- a third semiconductor layer of the first conductivity type formed in the second semiconductor layer and electrically isolated from the first semiconductor layer;
- a trench formed to extend from the surface of the third semiconductor layer and penetrate the third semiconductor layer and having depth to reach at least a portion lying near the first semiconductor layer;
- a first insulating film formed on side walls and a bottom portion of the trench;
- a first electrode formed at least partly on the first insulating film in the trench and electrically isolated from the first to third semiconductor layers; and

a fourth semiconductor layer of the first conductivity type formed near the trench on an interface between the first and second semiconductor layers and having an impurity concentration higher than that of the first semiconductor layer;

wherein an impurity concentration profile of the second semiconductor layer has a peak in a portion near an interface between the second and fourth semiconductor layers.

18. (Original) The semiconductor device according to claim 17, wherein film thickness of a portion of the first insulating film which lies near the bottom portion of the trench is larger than that of a portion of the insulating film which lies on the side wall portion of the trench.

19. (Original) The semiconductor device according to claim 17, wherein the fourth semiconductor layer is formed near the bottom portion of the trench.

20. (Original) The semiconductor device according to claim 17, wherein the trench is formed to penetrate at least part of the first semiconductor layer and the fourth semiconductor layer is formed on the side wall portion of the trench.

21. (Withdrawn) The semiconductor device according to claim 17, wherein the fourth semiconductor layer is a current passage acquiring layer formed between the first and second semiconductor layers and the trench is formed to have depth to reach the current passage acquiring layer.

22. (Withdrawn) The semiconductor device according to claim 21, wherein the current passage acquiring layer contains carbon.

23. (Original) The semiconductor device according to claim 17, wherein an interface between the second and first semiconductor layers is shallow in a portion near the trench and deep in a peripheral portion thereof.

24. (Original) The semiconductor device according to claim 23, wherein Y1 and Y2 are set to satisfy the relation of  $0 < Y1 < 1.2 [\mu\text{m}]$  and  $Y2 < 3 [\mu\text{m}]$  when the depth from the surface of the third semiconductor layer to the deepest bottom portion of the second semiconductor layer is set to Y2 [ $\mu\text{m}$ ] and the depth from the deepest bottom portion of the trench to the deepest bottom portion of the second semiconductor layer is set to Y1 [ $\mu\text{m}$ ].

25. (Original) The semiconductor device according to claim 17, further comprising a fifth semiconductor layer of the second conductivity type formed adjacent to the third semiconductor layer on the second semiconductor layer.

26. (Original) The semiconductor device according to claim 17, wherein the first electrode is formed of polysilicon.

27. (Original) The semiconductor device according to claim 17, wherein an upper portion of the first electrode partly protrudes from the trench.

28. (Original) The semiconductor device according to claim 27, further comprising a low-resistance layer formed on at least part of the surface of the first electrode which protrudes from the trench.

29. (Currently Amended) The semiconductor device according to claim 17 25, further comprising a second electrode formed on a rear surface of the first semiconductor layer which is opposite to the main surface thereof; a second insulating film formed on the first insulating film and the first electrode; and a third electrode formed on the third semiconductor layer, fifth semiconductor layer and second insulating film.

30. (Original) A semiconductor device comprising:

- a first semiconductor layer of a first conductivity type;
- a second semiconductor layer of a second conductivity type formed on a main surface of the first semiconductor layer;
- a third semiconductor layer of the first conductivity type formed in the second semiconductor layer;
- a trench formed to extend from the surface of the third semiconductor layer and penetrate the third semiconductor layer and having depth to reach at least a portion lying near the first semiconductor layer;
- a first insulating film formed on side walls and a bottom portion of the trench;
- a first electrode formed at least partly on the first insulating film in the trench; and
- a fourth semiconductor layer of the first conductivity type formed near the trench on an interface between the first and second semiconductor layers and having an impurity concentration higher than that of the first semiconductor layer;

wherein a region of not less than 60% of the second semiconductor layer has at least 40% of the maximum value of the impurity concentration of the second semiconductor layer.

31. (Original) The semiconductor device according to claim 30, wherein film thickness of a portion of the first insulating film which lies near the bottom portion of the

trench is larger than that of a portion of the insulating film which lies on the side wall portion of the trench.

32. (Original) The semiconductor device according to claim 30, wherein the fourth semiconductor layer is formed near the bottom portion of the trench.

33. (Original) The semiconductor device according to claim 30, wherein the trench is formed to penetrate at least part of the first semiconductor layer and the fourth semiconductor layer is formed on the side wall portion of the trench.

34. (Withdrawn) The semiconductor device according to claim 30, wherein the fourth semiconductor layer is a current passage acquiring layer formed between the first and second semiconductor layers and the trench is formed to have depth to reach the current passage acquiring layer.

35. (Withdrawn) The semiconductor device according to claim 34, wherein the current passage acquiring layer contains carbon.

36. (Original) The semiconductor device according to claim 30, wherein an interface between the second and first semiconductor layers is shallow in a portion near the trench and deep in a peripheral portion thereof.

37. (Original) The semiconductor device according to claim 36, wherein Y1 and Y2 are set to satisfy the relation of  $0 < Y1 < 1.2 [\mu\text{m}]$  and  $Y2 < 3 [\mu\text{m}]$  when the depth from the surface of the third semiconductor layer to the deepest bottom portion of the second

semiconductor layer is set to  $Y2 [\mu m]$  and the depth from the deepest bottom portion of the trench to the deepest bottom portion of the second semiconductor layer is set to  $Y1 [\mu m]$ .

38. (Original) The semiconductor device according to claim 30, further comprising a fifth semiconductor layer of the second conductivity type formed adjacent to the third semiconductor layer on the second semiconductor layer.

39. (Original) The semiconductor device according to claim 30, wherein the first electrode is formed of polysilicon.

40. (Original) The semiconductor device according to claim 30, wherein an upper portion of the first electrode partly protrudes from the trench.

41. (Original) The semiconductor device according to claim 40, further comprising a low-resistance layer formed on at least part of the surface of the first electrode which protrudes from the trench.

42. (Currently Amended) The semiconductor device according to claim ~~30~~ 38, further comprising a second electrode formed on a rear surface of the first semiconductor layer which is opposite to the main surface thereof; a second insulating film formed on the first insulating film and the first electrode; and a third electrode formed on the third semiconductor layer, fifth semiconductor layer and second insulating film.

43. (Currently Amended) A semiconductor device comprising:  
a first semiconductor layer of a first conductivity type;

a second semiconductor layer of a second conductivity type formed on a main surface of the first semiconductor layer;

a third semiconductor layer of the first conductivity type formed in the second semiconductor layer;

a trench formed to extend from the surface of the third semiconductor layer and penetrate the third semiconductor layer and having depth to reach at least a portion lying near the first semiconductor layer;

a first insulating film formed on side walls and a bottom portion of the trench;

a first electrode formed at least partly on the first insulating film in the trench; and

a fourth semiconductor layer of the first conductivity type formed near the trench on an interface between the first and second semiconductor layers and having an impurity concentration higher than that of the first semiconductor layer;

wherein the relation of  $0.05 < X1/X2 < 0.25$  is set up when the minimum width of  $[[an]]$  a repetition interval of elements is set at  $X2 [\mu m]$  and a distance between regions of the second semiconductor layer which face each other to sandwich the trench is set at  $X1 [\mu m]$ .

44. (Original) The semiconductor device according to claim 43, wherein film thickness of a portion of the first insulating film which lies near the bottom portion of the trench is larger than that of a portion of the insulating film which lies on the side wall portion of the trench.

45. (Original) The semiconductor device according to claim 43, wherein the fourth semiconductor layer is formed near the bottom portion of the trench.

46. (Original) The semiconductor device according to claim 43, wherein the trench is formed to penetrate at least part of the first semiconductor layer and the fourth semiconductor layer is formed on the side wall portion of the trench.

47. (Withdrawn) The semiconductor device according to claim 43, wherein the fourth semiconductor layer is a current passage acquiring layer formed between the first and second semiconductor layers and the trench is formed to have depth to reach the current passage acquiring layer.

48. (Withdrawn) The semiconductor device according to claim 47, wherein the current passage acquiring layer contains carbon.

49. (Original) The semiconductor device according to claim 43, wherein an interface between the second and first semiconductor layers is shallow in a portion near the trench and deep in a peripheral portion thereof.

50. (Original) The semiconductor device according to claim 49, wherein Y1 and Y2 are set to satisfy the relation of  $0 < Y1 < 1.2 [\mu\text{m}]$  and  $Y2 < 3 [\mu\text{m}]$  when the depth from the surface of the third semiconductor layer to the deepest bottom portion of the second semiconductor layer is set to Y2 [ $\mu\text{m}$ ] and the depth from the deepest bottom portion of the trench to the deepest bottom portion of the second semiconductor layer is set to Y1 [ $\mu\text{m}$ ].

51. (Original) The semiconductor device according to claim 43, further comprising a fifth semiconductor layer of the second conductivity type formed adjacent to the third semiconductor layer on the second semiconductor layer.

52. (Original) The semiconductor device according to claim 43, wherein the first electrode is formed of polysilicon.

53. (Original) The semiconductor device according to claim 43, wherein an upper portion of the first electrode partly protrudes from the trench.

54. (Original) The semiconductor device according to claim 53, further comprising a low-resistance layer formed on at least part of the surface of the first electrode which protrudes from the trench.

55. (Currently Amended) The semiconductor device according to claim 43 ~~51~~, further comprising a second electrode formed on a rear surface of the first semiconductor layer which is opposite to the main surface thereof; a second insulating film formed on the first insulating film and the first electrode; and a third electrode formed on the third semiconductor layer, fifth semiconductor layer and second insulating film.

56. (Withdrawn) A method of manufacturing a semiconductor device comprising:  
forming a second semiconductor layer of a second conductivity type on a first semiconductor layer of a first conductivity type;

forming a third semiconductor layer of the first conductivity type which is electrically isolated from the first semiconductor layer on a surface region of the second semiconductor layer;

forming a trench which extends from the surface of the third semiconductor layer, penetrates the third semiconductor layer and has depth to reach at least a portion lying near the first semiconductor layer;

forming a first insulating film on side walls and a bottom portion of the trench;

forming a fourth semiconductor layer of the first conductivity type near the trench on an interface between the first and second semiconductor layers, the fourth semiconductor layer having an impurity concentration higher than that of the first semiconductor layer; and

forming a first electrode at least partly on the first insulating film in the trench, the first electrode being electrically isolated from the first to third semiconductor layers;

wherein the forming the second semiconductor layer includes forming a first peak in a portion near an interface between the third and second semiconductor layers to determine threshold voltage, and forming a second peak which is lower than the first peak in a portion near an interface between the second and fourth semiconductor layers to determine a dose amount of the second semiconductor layer.

57. (Withdrawn) The method of manufacturing a semiconductor device according to claim 56, wherein the forming the second semiconductor layer includes forming the first peak by performing a first ion-implantation process and forming the second peak by selecting acceleration voltage higher than that used in the first ion-implantation process and performing a second ion-implantation process.

58. (Withdrawn) The method of manufacturing a semiconductor device according to claim 56, wherein the forming the second semiconductor layer is performed by use of a selective epitaxial growth method.

59. (Withdrawn) The method of manufacturing a semiconductor device according to claim 56, wherein the forming the fourth semiconductor layer is performed by use of an ion-implantation method.

60. (Withdrawn) The method of manufacturing a semiconductor device according to claim 56, wherein the forming the fourth semiconductor layer is performed by use of a selective epitaxial growth method.